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EFFECTS OF LOW-LEVEL LASER THERAPY OBSERVED IN INDIVIDUALS WITH DIABETES MELLITUS: A RETROSPECTIVE STUDY

EFEITOS DA LASERTERAPIA DE BAIXA INTENSIDADE OBSERVADOS EM PESSOAS COM DIABETES MELITO: UM ESTUDO RETROSPECTIVO

EFECTOS DE LA TERAPIA CON LÁSER DE BAJA INTENSIDAD OBSERVADOS EN PERSONAS CON DIABETES MELLITUS: UN ESTUDIO RETROSPECTIVO

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RESUMO

Objetivo: Descrever os efeitos da laserterapia de baixa intensidade observados em pessoas com diabetes melito. **Método:** Pesquisa documental e retrospectiva, realizada em um complexo ambulatorial de referência no estado do Rio de Janeiro. A coleta de dados ocorreu entre maio e julho de 2025, por meio de prontuários eletrônicos, dos quais foram extraídas informações referentes à indicação da laserterapia, dosimetria, tempo de tratamento e evolução clínica. Os dados foram analisados por meio de estatística descritiva simples. **Resultados:** Foram realizadas 402 sessões de laserterapia de baixa intensidade em 52 pacientes, com média anual de 133 aplicações. Destas, 361 (89,8%) corresponderam ao controle e tratamento adjuvante de infecções em membros inferiores, com destaque para onicomicoses (n=285; 70,9%), *tinea pedis* (n=61; 15,2%) e reparo tecidual (n=27; 6,7%), ao longo de 24 meses de acompanhamento. **Conclusão:** Os efeitos observados da laserterapia de baixa intensidade mostraram-se favoráveis em diferentes desfechos clínicos, incluindo melhora de infecções fúngicas, como onicomicose e *tinea pedis*, cicatrização de úlceras, redução de edema e alívio da dor.

Descritores: Terapia com Luz de Baixa Intensidade; Fotoquimioterapia; Diabetes Melito; Cuidados de Enfermagem.

ABSTRACT

Objective: To describe the effects of low-level laser therapy observed in individuals with diabetes mellitus. **Method:** A retrospective documentary study conducted at a reference outpatient health care complex in the state of Rio de Janeiro. Data collection took place between May and July 2025 through electronic medical records, from which information regarding laser therapy indications, dosimetry, treatment duration, and clinical progression was extracted. Data were analyzed using simple descriptive statistics. **Results:** A total of 402 low-level laser therapy sessions were performed in 52 patients, with an annual mean of 133 applications. Of these, 361 (89.8%) corresponded to the control and adjunctive treatment of lower-limb infections, mainly onychomycosis (n=285; 70.9%), *tinea pedis* (n=61; 15.2%), and tissue repair (n=27; 6.7%), over 24 months of follow-up. **Conclusion:** The observed effects of low-level laser therapy were favorable across different clinical outcomes, including improvement of fungal infections such as onychomycosis and *tinea pedis*, ulcer healing, edema reduction, and pain relief.

Descriptors: Low-Level Light Therapy; Photochemotherapy; Diabetes Mellitus; Nursing Care.

RESUMEN

Objetivo: Describir los efectos de la terapia láser de baja intensidad observados en personas con diabetes mellitus. **Método:** Investigación documental y retrospectiva, realizada en un complejo ambulatorio de referencia en el estado de Río de Janeiro. La recolección de datos se llevó a cabo entre mayo y julio de 2025, mediante historias clínicas electrónicas, de las cuales se extrajo información referente a la indicación de la terapia con láser, dosimetría, tiempo de tratamiento y evolución clínica. Los datos fueron analizados mediante estadística descriptiva simple. **Resultados:** Se realizaron 402 sesiones de terapia láser de baja intensidad en 52 pacientes, con un promedio anual de 133 aplicaciones. De estas, 361 (89,8%) correspondieron al control y tratamiento adyuvante de infecciones en miembros inferiores, con énfasis en onicomicosis (n=285; 70,9%), *tinea pedis* (n=61; 15,2%) y reparación tisular (n=27; 6,7%), a lo largo de 24 meses de seguimiento. **Conclusión:** Los efectos observados de la terapia láser de baja intensidad se mostraron favorables en diferentes desenlaces clínicos, incluyendo mejoría de infecciones fúngicas, como onicomicosis y *tinea pedis*, cicatrización de úlceras, reducción de edema y alivio del dolor.

Descriptores: Terapia Láser de Baja Intensidad; Fotoquimioterapia; Diabetes Mellitus; Cuidados de Enfermería.

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What is already known:

- Low-level laser therapy (LLLT) has analgesic, anti-inflammatory, and wound-healing effects and is used as an adjunctive treatment for diabetes-related lesions.
- Photodynamic therapy combined with laser therapy can be used to control fungal infections, including onychomycosis and *tinea pedis*.

What this article adds:

- Onychomycosis accounted for 70.9% of LLLT applications, constituting the primary therapeutic indication observed.
- Clinical improvements were observed in 80% of onychomycosis cases, 77.8% of *tinea pedis* cases, and 100% of infected lesions.
- Regarding tissue repair, all patients showed a reduction in PUSH scores, indicating improved healing of the monitored lesions.

INTRODUCTION

Low-level laser therapy (LLLT) has become established as a highly relevant technology in contemporary nursing clinical practice, contributing to wound healing management, pain control, edema reduction, modulation of the inflammatory process, and control of infectious processes associated with different health conditions, especially complications related to diabetes mellitus (DM)[1].

Sustained hyperglycemia may trigger complications in different organ systems, including the cardiovascular, renal, neural, and ocular systems. Among the complications frequently observed in individuals with DM, with an estimated incidence of one case in every four individuals, lower-extremity impairment stands out, referred to as diabetes-related foot disease, which occurs as a consequence of diabetic polyneuropathy, often associated with peripheral arterial disease[2-3].

Loss of protective sensation may worsen trauma and foot injuries in individuals living with diabetes, as these individuals may not perceive the occurrence of such damage. Furthermore, over time, they may develop deformities resulting from osteoarticular destruction, compromising gait and altering functional biomechanics[4].

Among the adjunctive therapies used in the treatment of lower-extremity conditions in individuals with DM, LLLT stands out because of its favorable cost-effectiveness, as it is a noninvasive and painless intervention capable of directly acting on the physiological and biochemical events involved in tissue repair processes[5].

LLLT consists of a therapeutic resource based on the emission of low-power nonionizing electromagnetic radiation, capable of acting as a cellular and tissue biomodulator, promoting repair through cell proliferation, tissue neoformation, revascularization, microcirculation stimulation as well as antiedematous and analgesic effects[6].

In this context, laser therapy has been incorporated into clinical practice in different health care fields, including nursing, in the care of individuals with DM. LLLT may be used to promote tissue repair in muscle, bone, joint, and skin injuries[6].

Radiation emitted by low-power lasers presents analgesic, anti-inflammatory, and wound-healing effects and has been widely used in tissue repair because of the low energy densities employed and wavelengths capable of penetrating tissues[5].

LLLT acts on skin wound healing by accelerating physiological processes involved in healing, stimulating neoangiogenesis, promoting protein synthesis, remodeling wound edges, and reducing pain. These effects result from photochemical interactions capable of increasing cellular metabolism and inducing analgesic, anti-inflammatory, and reparative responses, depending on the technique and protocol used[7].

Additionally, properties related to controlling uncontrolled tumor cell growth and antimicrobial action achieved through photodynamic therapy (PDT) should be highlighted[8].

PDT consists of the combination of three components: a photosensitizing agent, a light source, and molecular oxygen, aiming to promote localized oxidative photodamage, enabling action in different pathological processes. Activation of the photosensitizer by light promotes energy transfer to molecular oxygen, resulting in immediate cell death[8-9].

The destruction of bacteria and fungi occurs through mechanisms related to electron or hydrogen transfer, leading to free radical production (type I reaction), or through energy transfer to molecular oxygen (type II reaction), inducing singlet oxygen formation, a reactive species responsible for microorganism death[9].

Although laser therapy is considered a relatively recent practice in Brazilian health care institutions, its use is widespread internationally[7]. There is still a gap in national scientific knowledge regarding LLLT, which highlights the need for studies that expand evidence related to the relevance of this technology as an auxiliary nursing care resource.

The following research question was formulated: what are the effects of LLLT in individuals with DM?

Thus, this study aimed to describe the effects of LLLT in individuals with DM.

METHOD

This was a descriptive, documentary, retrospective study with a quantitative approach, developed according to the recommendations of the *STrengthening the Reporting of OBservational studies in Epidemiology*[10].

Study setting

The study was conducted in a nursing service specialized in clinical podiatry located in a public university outpatient referral complex in the state of Rio de Janeiro.

Data collection period

Medical records of individuals with DM who underwent intervention with LLLT during a 24-month period

between May 2022 and May 2024 were analyzed. Data collection occurred between May and July 2025 through documentary sources.

Inclusion and exclusion criteria

Electronic and printed medical records from the service containing information related to patients undergoing LLLT were included, including therapeutic indication, dosimetry, treatment duration, and clinical progression.

Medical records with incomplete information, records of treatment interruption during the evaluated period, and patients receiving antibiotic therapy or antifungal therapy concomitantly with LLLT intervention were excluded.

Population and sample

The population consisted of medical records from patients with diabetes treated in the service and undergoing LLLT. Of the 67 medical records initially identified, 52 met the inclusion criteria and comprised the final study sample.

Data collection

Data collection was performed through consultation of the service's electronic and printed medical records. Information regarding LLLT indication, dosimetry, treatment duration, and clinical progression was extracted to identify the following outcomes: improvement in fungal infection, improvement in ulcer healing, edema reduction, and pain relief.

For data organization, participants were allocated into groups according to the therapeutic indication of LLLT. Group I consisted of participants undergoing LLLT for antimicrobial purposes to control lower-extremity infections and was subdivided into: subgroup IA, onychomycosis treatment; subgroup IB, *tinea pedis* treatment; and subgroup IC, infected wound treatment.

Group II consisted of participants undergoing LLLT to promote tissue repair directed toward healing lesions without signs of infection. Group III included participants reporting pain who underwent LLLT for analgesia. Finally, Group IV consisted of participants undergoing LLLT for lower-extremity edema drainage.

Intervention

Group I was treated with LLLT combined with PDT. The technique consisted of applying a 0.5% methylene blue solution over the treated area, including the nail plate in cases of onychomycosis, the interdigital region in cases of *tinea pedis*, and infected skin lesions. After application of the photosensitizer, a 5-minute interval was observed to allow impregnation of the solution into the treated area. Subsequently, LLLT was applied using a low-power red laser, wavelength of 660 nm, and dosimetry of 12 J/cm^2.

Participants with onychomycosis underwent five weekly sessions of LLLT combined with PDT, totaling 5 weeks of treatment, with reassessment after 6 months because of nail plate growth time. Participants with *tinea pedis* were treated in a single session, with reassessment after 2 weeks. In cases of recurrence, the therapeutic protocol was repeated, respecting a maximum limit of four sessions.

Participants in subgroup IC received weekly LLLT applications, with clinical wound reassessment at each session to monitor signs suggestive of infection.

The service adopted a standardized wound treatment routine, including removal of the previous dressing, assessment of exudate amount, wound cleansing with 0.9% saline solution, wound measurement using a disposable ruler, and assessment of the predominant tissue in the wound bed. Photographic documentation was also performed upon patient authorization and signing of an image use consent form, followed by documentation of nursing progression in the electronic medical record.

Healing assessment used the *Pressure Ulcer Scale for Healing* (PUSH), which has been validated and cross-culturally adapted for Brazil. The instrument considers three parameters: wound area in cm^2, amount of exudate, and appearance of the predominant tissue in the wound bed. The sum of scores results in a total score ranging from 17 to 0, with 0 indicating a healed wound.

Group II received LLLT for tissue repair using simultaneous red and infrared laser emission, wavelength of 660 nm, and dosimetry of 4 J/cm^2. Applications were performed weekly, with reassessment of healing progression using the PUSH scale.

Participants in Group III received LLLT for analgesia using a low-power infrared laser, with a dosimetry of 36 J applied to the painful area. Treatment was performed in a single session, with application of the visual analog pain scale before and immediately after intervention.

Group IV received LLLT for edema drainage using a low-power infrared laser, with a dosimetry of 2 J applied along the lymphatic chain of the lower extremities. Sessions occurred weekly, with clinical reassessment and limb circumference measurement using measuring tape.

In all groups, the point application technique was used, with irradiation over an area of 1 cm^2.

Technical procedures

The equipment used for LLLT application was the Easy Laser model, patented by Instituto Ricardo Trajano in 2009 and registered with the Brazilian Health Regulatory Agency under registration number 80030819009.

The equipment has a power output of 100 mW and simultaneous low-power red and infrared laser emission capability. The wavelengths used were 660 nm and 808 nm, respectively, in continuous mode. Fiber optic transmission enabled emission of a collimated beam directed toward the target tissue.

Outcomes

The evaluated outcomes were improvement in fungal infection, improvement in ulcer healing, edema reduction, and pain relief. Information was obtained from nursing progression records and organized into spreadsheets for subsequent analysis.

Data analysis

Data were organized into a Microsoft Excel 2010 database, categorized according to identified outcomes, and analyzed using simple descriptive statistics. Results were presented in tables containing absolute and relative frequencies and discussed considering the relevant scientific literature.

Ethical aspects

The study complied with ethical principles applicable to research involving human participants. The project was registered on the Brazilian Ministry of Health's Plataforma Brasil and approved by the institution's human research ethics committee where the study was developed, under approval number 4.814.895 and CAAE 48470721.1.0000.5282.

As this was documentary research, informed consent was waived. However, all necessary measures were adopted to ensure participant privacy, confidentiality, and anonymity throughout all stages of the study.

RESULTS

When investigating the indications for LLLT, it was possible to identify and stratify its use according to clinical purpose, grouping it into the following categories: infection treatment (onychomycosis, *tinea pedis*, and infected wounds), tissue repair (lesion healing), analgesia, and edema drainage, as presented in Table 1.

Table 1 - Applications of LLLT in the clinical podiatry nursing service. Rio de Janeiro, RJ, Brazil, 2025 (n=402)

	Number of applications per year				
LLLT indication	**2022**	**2023**	**2024**	**Total**	**%**
Infection (onychomycosis)	219	52	14	285	70.9
Fungal infection (*tinea pedis*)	39	16	6	61	15.2
Wound infection	6	9	0	15	3.7
Tissue repair	12	8	7	27	6.7
Analgesia	6	2	2	10	2.5
Edema drainage	4	0	0	4	1.0
Total	**286**	**87**	**29**	**402**	**100**

Source: prepared by the authors, 2025.

Data analysis identified a total of 402 LLLT sessions, with an annual average of 133 applications. Among the therapeutic indications observed, a predominance of LLLT use for infection control and adjunctive treatment was identified, particularly for onychomycosis, which accounted for 285 applications (70.9%).

Interventions targeting *tinea pedis* corresponded to 61 applications (15.2%), followed by treatment of infected wounds, with 15 applications (3.7%). Tissue repair accounted for 27 applications (6.7%), whereas analgesia and edema drainage corresponded to 10 (2.5%) and 4 applications (1.0%), respectively.

Clinical outcomes associated with LLLT application are described in Table 2.

Table 2 - Outcomes observed after LLLT application in the clinical podiatry nursing service. Rio de Janeiro, RJ, Brazil, 2025 (n=402)

Indications	**n**	**Outcomes (%)**		
Group I		**Clinical improvement**		**No improvement**
Onychomycosis	20	80		20
Tinea pedis	9	78		22
Infected lesions	10	100		0
Group II		**Complete healing**	**Improved healing**	**No improvement**
Tissue repair	9	55.5	44.5	0
Group III		**Pain relief**		**No improvement**
Analgesia	3	100		0
Group IV		**Edema reduction**		**No improvement**
Edema drainage	1	100		0

Source: prepared by the authors, 2025.

In Group I, five patients with *tinea pedis* (55.5%) achieved complete resolution after only one LLLT session. Additionally, all patients undergoing treatment for infection control in lesions — characterized by perilesional erythema, appearance of the predominant tissue in the wound bed, type and amount of exudate, and presence of odor — demonstrated improvement in the infectious condition compared with baseline status.

In Group II, related to tissue repair, outcomes were assessed using the PUSH scale, with score reduction observed

in all monitored lesions. The mean treatment duration was 126 days, with an average of seven LLLT sessions per lesion.

In Group III, outcome assessment was performed using a visual analog scale applied before and after treatment. Reduction in pain scores was observed in all patients undergoing LLLT.

Regarding Group IV, only one patient received treatment for edema drainage during a 4-week period, with one weekly application. Reductions of 2-4 cm in the circumference of the affected limb were observed, indicating clinical improvement after LLLT treatment.

Analysis of outcomes across the studied groups demonstrated that no patient undergoing LLLT presented clinical progression records indicating worsening compared with baseline condition before treatment.

DISCUSSION

The results of this study demonstrated the therapeutic effects of LLLT as an auxiliary resource in the clinical care of individuals with DM within the nursing context. The use of LLLT requires specific professional training, as its application demands knowledge related to therapeutic prescription, physics, dosimetry, biophotonics, laser-tissue interaction, and human physiology. In this context, LLLT is incorporated into nursing practice through the Nursing Process[11].

The action of LLLT and its applicability in microbial photoinactivation have been used in the treatment of dermatophytoses, including fungal nail infections (onychomycosis), interdigital fungal infections (*tinea pedis*), and infections in skin lesions. The antimicrobial effect is enhanced when LLLT is combined with photosensitizing agents through PDT[12-13].

A review addressing onychomycosis treatment, including therapeutic modalities approved by the U.S. Food and Drug Administration, analyzed clinical trials and case studies involving PDT and identified evidence of mycological cure in patients undergoing this therapeutic strategy[13]. In Canada, studies have indicated laser therapy as an alternative to topical antifungal treatments, which although safe show lower effectiveness when compared with oral treatments and often require prolonged therapeutic periods, favoring treatment discontinuation by patients[12].

Regarding the use of LLLT combined with PDT for the treatment of interdigital dermatophytosis (*tinea pedis*), a literature review analyzing national and international publications on PDT in dermatomycosis treatment identified favorable results in *in vivo* studies, demonstrating the therapeutic potential of this technology. The authors also emphasized the need for further studies evaluating the effects of PDT in dermatomycosis management[14].

These findings corroborate the results of the present study, in which 80% of patients with toenail onychomycosis demonstrated clinical improvement after LLLT treatment. Similarly, 77.8% of participants with *tinea pedis* showed favorable progression compared with baseline condition.

Regarding infected wound treatment, a systematic review demonstrated that PDT promotes significant reduction in infectious infiltrate, favoring positive clinical outcomes in wounds of individuals with DM and potentially contributing to reduced rates of nontraumatic amputations. Additionally, PDT has been highlighted as a promising therapeutic strategy for treating microorganisms resistant to conventional antibiotic therapy, since there are currently no reports in the literature of microbial resistance associated with LLLT[5].

These benefits support the findings of the present investigation, in which 100% of lesions presenting clinical signs of infection demonstrated clinical improvement after treatment, regardless of lesion etiology.

In the context of tissue biostimulation, LLLT accelerates regenerative processes and improves the quality of repaired tissue by acting on physiological and biochemical events related to healing, including inflammatory modulation, collagen synthesis, granulation tissue formation, and reepithelialization. The absorbed energy is converted into adenosine triphosphate (ATP), being used in cellular metabolic processes such as cell proliferation, protein synthesis, and acceleration of tissue repair in animal and human models[15].

A systematic review with meta-analysis conducted in China, including 13 randomized clinical trials and 413 patients with diabetes and chronic foot lesions, evaluated the effects of LLLT using the PUSH scale. Results demonstrated significant improvement in tissue repair among participants undergoing LLLT compared with the control group, in addition to greater epithelial tissue formation, reduction of inflammatory processes, granulation tissue proliferation, and improved skin conditions in diabetic foot[16]. Similarly, the findings of the present study demonstrated clinical improvement in all patients undergoing LLLT for tissue repair.

The anti-inflammatory effects of LLLT have also been attributed to increased neovascularization, fibroblast proliferation, and reduction of inflammatory infiltrate, in addition to modulation of cytokines and growth factors, favoring a more efficient and organized healing process[5].

Regarding the analgesic effect of LLLT, a *crossover* study conducted with 20 patients undergoing photobiomodulation for lower-extremity pain control identified immediate clinical improvement in 18 participants after the first therapeutic session, with maintenance of pain reduction over the subsequent 4 days[17].

Analgesia provided by LLLT occurs because of its anti-inflammatory properties, related to prostaglandin conversion into prostacyclins as well as its regenerative effects on neurons. Although its mechanism of action remains incompletely understood, several mechanisms have been associated with LLLT effects, including increased local blood flow, reduced peripheral nerve activity, stimulation of homeostasis, endorphin production, and activation of mitochondrial metabolic processes, promoting increased intracellular ATP production[18].

LLLT also presents important antiedematous effects. Acceleration of microcirculation resulting from changes in capillary hydrostatic pressure favors edema drainage and elimination of accumulated intermediate catabolites[19].

The effectiveness of this drainage process is also related to fibrinolytic action, promoting resolution of isolation caused by plasma coagulation and facilitating a

more efficient supply of nutritional elements and defense mechanisms to the affected region, contributing to tissue regeneration[20].

Analgesia-related effects were observed in 100% of cases analyzed in this study. Among patients undergoing LLLT for pain control, 66.7% progressed from severe pain to moderate pain, whereas 33.3% demonstrated reduction from severe pain to mild pain.

Regarding edema drainage, initial clinical improvement was observed in one treated limb. However, the therapeutic protocol had to be interrupted because of referral of the patient through the National Regulation System for surgical intervention.

LLLT has demonstrated relevance as a therapeutic tool in nursing care for individuals with DM, particularly because of its favorable cost-effectiveness, noninvasive nature, absence of pain during application, and therapeutic potential. These attributes may contribute to improving quality of life in patients requiring specialized foot care[9].

Thus, retrospective analysis of patients undergoing LLLT in the context of this study demonstrated favorable outcomes regarding fungal infection improvement, ulcer healing, edema reduction, and pain relief.

Among the study limitations, data loss resulting from incomplete medical records, temporary absence of documentation caused by institutional internet unavailability, and operational failures in the electronic medical record system should be highlighted. Additionally, because this was a descriptive study conducted in a single health care setting, the results should not be generalized to other contexts.

CONCLUSION

The findings of this study demonstrated favorable effects of LLLT in individuals with DM. Although the literature predominantly emphasizes its use in wound healing processes, the observed results also indicated benefits in other clinical applications, including treatment of dermatophytoses, analgesia, edema drainage, and local and systemic inflammatory control.

Further research on the use of LLLT in nursing is recommended, particularly studies related to standardization of dosimetry and wavelength parameters for different clinical conditions. Future studies are needed to strengthen scientific evidence and provide more consistent guidance regarding the application of this technology in nursing care, considering its potential as a promising therapeutic tool in health care.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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